



Nanotechnology and the Environment

EPA STAR Progress Review Workshop

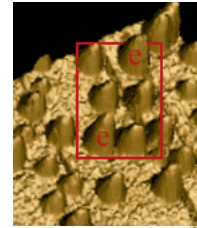
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We are at the beginning of a Revolution in:

How things are made



Where things are made



And whether they are made



Rejeski, 2003



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Purpose of this workshop

- To present the latest results of EPA and other research on environmental applications and implications of nanotechnology
- To provide a stimulus for increased collaborations among the various researchers; and
- To improve knowledge of the environmental aspects of nanotechnology and future research needs.



What is nanotechnology?

While many definitions for nanotechnology exist, the NNI* calls it "nanotechnology" only if it involves **all** of the following:

1. Research and technology development at the atomic, molecular or macromolecular levels, in the **length scale** of approximately 1 - 100 nanometer range.
2. Creating and using structures, devices and systems that have **novel properties and functions** because of their small and/or intermediate **size**.
3. Ability to **control or manipulate** on the **atomic scale**.

***National Nanotechnology Initiative**



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EPA's Roles in Nanotechnology

- Provide leadership under the NNI on the environmental applications and implications of nanotechnology
- Work in collaboration with federal agencies and other organizations to identify research priorities to support safe development of nanotechnology
- Support research directly and in collaboration with other agencies to address research priorities
- Address nanotechnology as appropriate under EPA's statutes to protect human health and the environment



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Applications and Implications

Applications address existing environmental problems, and prevent future problems

Implications address the interactions of nanomaterials with the environment, and any possible risks that may be posed by nanotechnology



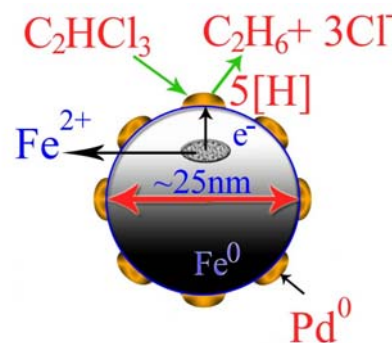
Examples of Environmental Applications

<i>Air</i>	nanofiber filters; sensors
<i>Water</i>	sensors; treatment
<i>Waste</i>	waste minimization, remediation
<i>Toxics</i>	green chemistry; treatment
<i>Homeland Security</i>	chemical/biological sensors; decon



Early Application: Remediation using nanoscale Iron particles

- nanoscale zero valent iron particles are deployed in-situ to remediate soil and ground water contaminated with chlorinated compounds and heavy metals



Environmental Implications

Do manufactured nanomaterials present a risk to human health and the environment?

- Unique properties of nanotech
- Many unknowns: toxicity, exposure, transport, bioaccumulation, persistence, transformation
- Potential toxicity through inhalation and skin exposure routes
- Potential effects may be informed by ultrafines



Sample EPA Grants Research Focusing on Nano Environmental Implications

Transformations of Biologically Conjugated CdSe Quantum Dots Released Into Water and Biofilms	CdSe Quantum Dots	
	Holden, Patricia	UC-Santa Barbara

Iron Oxide Nanoparticle-Induced Oxidative Stress and Inflammation	Fe nanoparticles	
	Elder, Alison	Univ. Rochester

A Focus on Nanoparticulate Aerosol and Atmospherically Processed Nanoparticulate Aerosol		
	Grassian, Vicki	Univ. Iowa

Physical and Chemical Determinants of Nanofiber/Nanotube Toxicity	Carbon nanotubes; other fibers	
	Hurt, Robert	Brown Univ.

Short-Term Chronic Toxicity of Photocatalytic Nanoparticles to Bacteria, Algae, and Zooplankton	TiO ₂ nanoparticles	
	Huang, Chin-pao	Delaware

Responses of Lung Manufactured Nanoparticles	Iron Oxide nanoparticles	
	Veranth, John	Univ. Utah



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EPA Nanotechnology STAR Grants

- 2001 Environmental Applications of Nanotechnology
 - 16 awards, \$5.6 million
- 2002 Environmental Applications of Nanotechnology
 - 16 awards, \$5 million
- 2003 Health and Environmental Effects of Manufactured Nanomaterials
 - 12 awards, \$4 million
- 2001 Environmental Applications of Nanomaterials
 - 7 awards, \$2 million
- 2004/5 Health and environmental effects of Nanoparticles
 - \$6 million (awards pending), joint with NSF, NIOSH
- 2005/6 Health and Environmental effects of Nanomaterials
 - Release Oct 05, joint with NSF, NIOSH, NIEHS



Science Needs and Challenges

Identify how nanoscience can be used for beneficial environmental applications.

- Measurement techniques and sensors
- Control and remediation technologies
- Pollution prevention and sustainability

Understand and predict the human health and ecological implications of nanoparticle releases to the environment.

- Nomenclature and characterization
- Fate, transport and exposure, biokinetics
- Toxicity of nanoparticles and their byproducts
- Life cycle assessment



Integrating Science Needs

EPA's nanotechnology research needs are being integrated with needs of other regulatory agencies through the NSET Nanotechnology Environmental Health and Implications (NEHI) Workgroup.



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EPA Regulatory Challenges

- What provisions of EPA regulations or authorities may apply to nanotechnology ?
- Will regulations need to be adapted or changed?
- How can nanotechnology improve compliance and reduce costs?
- What information does each office need to address these issues?
- What voluntary approaches may be appropriate?



EPA Nanotechnology White Paper

- In December 2004, EPA formed a Nanotechnology Impact Workgroup.
- Workgroup charged to develop a white paper on nanotechnology that examines the potential applications and implications to human health and the environment.
- Over 60 people from across EPA engaged in the effort.
- Paper currently undergoing internal Agency review; will undergo external peer review.
- Aiming to issue final document in January 2006.



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Programmatic Activities

- On September 29 and October 12, 2005, OPPT's National Pollution Prevention and Toxics Advisory Committee held public meetings of its Interim Ad Hoc Work Group on Nanoscale Materials. The purpose of the meetings were to further discuss and receive additional public input on issues pertaining to the voluntary program for nanoscale materials
- OPPT plans to announce a program in late 2005 or early 2006
- OPPT has "permitted limited manufacture" under TSCA of a low-volume exemption for a nanomaterial. This is EPA's first; more are in the queue.



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*Information on EPA's
Nanotechnology Research Programs*

www.epa.gov/ncer/nano

*Information on OPPT's voluntary
reporting program*

www.epa.gov/docket
OPPT-2004-0122



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